


A Measure of Resistance

Detecting Tamiflu Metabolite in Sewage Discharge and River Water

During the flu season each year, combating the different strains of the influenza virus becomes a public health priority, with treatment dependent upon two groups of antiviral drugs: neuraminidase inhibitors and M2 ion channel inhibitors. Oseltamivir phosphate, marketed as Tamiflu, is a popular neuraminidase inhibitor widely used to treat flu symptoms. Oseltamivir carboxylate (OC), Tamiflu's active metabolite, is known to withstand activated sludge treatment at sewage treatment plants (STPs), but less is known about how much OC may make its way into waterways that receive STP effluent. Now a new study conducted in Kyoto City, Japan,



Resistance in the making? Potential influenza A host meets potential source of active Tamiflu metabolite

during the 2008–2009 flu season reports some of the first measurements of OP occurrences in STP discharge and in river water [*EHP* 118:103–107; Ghosh et al.].

According to the World Health Organization, between 250,000 and 500,000 people die each year from influenza, and each year, millions of people take Tamiflu to battle flu symptoms. After the sewage treatment process, the excreted active metabolite remains in STP effluent and travels to waterways where effluent is discharged.

The investigators in the current study collected samples from STP effluent and from river water on three different occasions: at the beginning of the flu season, during the peak period, and 2 weeks after the peak period. Using solid-phase extraction followed by liquid chromatography–tandem mass spectrometry, they measured the highest concentration of OC, 293.3 ng/L, in an STP discharge sample collected during the peak of the flu season. Concentration amounts were higher in effluent from STPs that used traditional activated sludge treatment; in contrast, effluent from plants that used advanced ozonation as tertiary treatment contained significantly lower OC levels (37.9 ng/L). River water samples showed a range of OC levels from 6.6 to 190 ng/L during the peak of the flu season.

Previous research indicates OC concentrations ranging from 80 to 230 ng/L will disable 50% of the influenza virus. This level of exposure is most likely to kill virus particles that are particularly susceptible to OC, while selecting for viruses that are resistant to the drug's effects. The authors note, "During a common flu season, waterfowl can ingest large quantities of OC with virus. . . . Exposing waterfowl infected with influenza A virus to elevated levels of OC in open waterways could trigger the development of Tamiflu-resistant viral strains."

The authors suggest ozonation as tertiary treatment that may reduce OC load in STP effluent. They also recommend conducting further investigations to determine the fate of antiviral drugs at every interval of the STP process.

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No Small Worry

Airborne Nanomaterials in the Lab Raise Concerns

The use of engineered nanomaterials has grown dramatically over the past decade as the pharmaceutical, electronics, and other industries leverage these materials' unique physical and chemical properties. In environmental circles, nanomaterials have aroused concern because, even as their use burgeons, their impact on animal and plant life remains largely unknown. Moreover, scientists studying the environmental effects of nanomaterials might unknowingly be putting their own health at risk [*EHP* 118:49–54; Johnson et al.].

The National Institute for Occupational Safety and Health, which conducts research on workplace safety, has no recommended exposure limit guidelines for nanomaterials, and the Occupational Safety and Health Administration has no permissible exposure limit specific to engineered nanomaterials. However, recent animal toxicology studies suggest nanomaterials may cause specific adverse health effects. For example, carbon nanotubes have been shown to induce inflammation and oxidative stress in animal models.

To assess the magnitude of potential exposure in a laboratory setting, a team of researchers measured the amount of carbonaceous nanomaterials (CNMs) released into the air during routine material handling and processing tasks in standard environmental matrices such as artificial river water. The authors evaluated nanomaterial releases using real-time particle counters and transmission electron microscopy.

The research team found that CNMs became airborne when they were handled and weighed in the lab. Smaller structures, with an aerodynamic diameter of less than 1 μm , scattered more readily than larger particles.

A surprise finding was the substantial release of CNMs during sonication, a common laboratory process used to break apart agglomerates of nanomaterials into aqueous dispersions. Sonication produced a CNM-containing mist that could be inhaled by workers or that could leave CNMs on laboratory surfaces after the water evaporated. The extent of release during sonication was increased when natural organic matter was added to the solution, as is often done to simulate conditions in the environment. Hydrophobic CNMs exhibited higher airborne particle number concentrations during handling than during sonication, whereas hydrophilic CNMs exhibited the opposite trend.

These findings contradict the belief that risks of exposure are minimized when working with nanomaterials in liquid suspensions. The authors believe this field case study is the first to demonstrate the release of CNMs during sonication and also the first to detail nanomaterial release in an environmental laboratory. They caution that more robust statistically based experimental research is needed to evaluate CNM exposure among laboratory workers. Until then, they urge researchers working with nanomaterials to use appropriate personal protective equipment in the laboratory and to adopt adequate engineering controls to minimize their exposure.

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